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THE CRANBERRY ROOTWORM.[1]

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INTRODUCTION.[2]

The investigation of cranberry insects in New Jersey has included the biological study of a beetle, well known to collectors for more than a century, but unrecorded, until recently, as a pest to the cranberry. Attention was first called to it on the cranberry bogs by Mr. T. B. Gaskill, of New Egypt, N. J., who reported injury in a bog in his vicinity and sent specimens of larvæ, pupæ, and beetles to the Bureau of Entomology for determination. Adult specimens, submitted to Mr. E. A. Schwarz, were determined as *Rhabdopterus picipes* Oliv., of the family Chrysomelidæ.

Mr. A. L. Quaintance (1912),[3] of the Bureau of Entomology, after making a visit to the infested bog in June of 1912, presented his observations on the extent and character of the injury and the feeding and probable egg-laying habits of the beetle before the Entomological Society of Washington. These notes were the first published records pertaining to the economic importance of this insect.

Rhabdopterus picipes was first described by Olivier (1808) from the collection of Bosc in the Jardin des Plantes, Paris, being placed by him in the genus Colaspis. It was later described by Say (1824) under the name *Colaspis pretexta*. Le Conte, when he edited the writings of Say (1859), made note that *Colaspis pretexta* Say is *Colaspis picipes* Oliv. The genus Rhabdopterus was erected by Lefevre in 1885, and a few years later Horn (1892) transferred *picipes* from Colaspis to Rhabdopterus.

Later writers have made mention of the food plants of the beetle, but only one larval host is known. With the finding of the larvæ on cranberry roots and the dying of the vines in infested areas it was deemed advisable to devote special attention to the habits and

[1] *Rhabdopterus picipes* Oliv.; order Coleoptera, family Chrysomelidæ.

[2] The illustrations used in this paper are from photographs by Messrs. H. K. Plank and J. H. Paine, of the Bureau of Entomology. The author is also pleased to acknowledge the assistance of Mr. Plank in carrying on life-history studies of the cranberry rootworm.

[3] Bibliographic citations in parentheses refer to "Literature cited," p. 8.

distribution of the insect with a view to devising means of control, (1) by spraying, (2) by the use of water for flooding operations, and (3) by cultural treatment of the bogs. Observations continued through a period of two years indicate that at the present time the pest is not one of prime importance on cranberry bogs and that its ravages are not to be compared in severity with those of the cranberry girdler (*Crambus hortuellus* Hübn.) to which insect probably the injury produced by the rootworm has heretofore been attributed.

DISTRIBUTION.

The cranberry rootworm is widely disseminated throughout the United States and is also reported from Canada. Blatchley (1910) reports it in Indiana and further states that it occurs from Massachusetts to Dakota and south to North Carolina. In the collection of the Philadelphia Academy of Natural Sciences specimens are exhibited from Utah, Nebraska, Illinois, "Dakota," southwestern Texas, Florida, Delaware, Pennsylvania, New Jersey, and Canada. Smith (1909) lists it from New Jersey south of the Piedmont Plain. The present investigation has led to its capture on one or more cranberry bogs at or near the following places in New Jersey: Pemberton, New Lisbon, Whitesbog, New Egypt, Cookstown, Chatsworth, Pasadena, Medford, and Brookland.

FOOD PLANTS.

Few plants are recorded as hosts of the beetle. Say states that it is common on the myrtle, while Blanchard found it abundant on basswood. In Indiana it is reported on wild grape, and Smith lists it in New Jersey on myrtle, grape, and basswood. More recent observations have shown that the beetle is a feeder on foliage and fruit of the cranberry, and the writer has taken it on blueberry and inkberry by jarring. The larvæ are abundant on the roots of cranberry.

CHARACTER AND EXTENT OF INJURY.

The chief injury to the cranberry is caused by the feeding of the larvæ on the roots and runners (Pl. I, fig. 2), where the latter come in contact with the ground. As a rule only the bark is eaten from the large and secondary roots, the wood occasionally being attacked, while the fibrous roots (Pl. I, fig. 1), which are so numerous as to form a dense mat an inch or more in thickness, are completely devoured. The character of the rootworm injury is such that one can distinguish between it and the injury produced by the cranberry girdler. The larvæ of the latter insect prefer the runners and crowns of the plants and not only feed on the bark but devour the wood, often eating completely through a runner. In a general way it may be said that the rootworm feeds in the soil, while the girdler feeds on the surface, concealed in the trash which lies on the ground.

The vines which suffer the most are those growing on sandy land or what are usually termed "savannas." Larvæ have been found in

several instances in peat bottoms, where the roots of the vines may travel a foot in depth, but in these instances the dying of the vines could usually be traced to the feeding of the cranberry girdler.

When the root feeding is severe the vines show signs of weakening in the early fall. The leaves dry out, turn red or brown, and before growth starts the following season most of them will have shattered to the ground, leaving the dead uprights and runners bare of green foliage. Small areas are thus killed out, almost invariably at the margins of the bogs or on relatively high and sandy areas in the interior of the bogs. (Pl. II, fig. 1.) The mud and peat bottoms rarely suffer from rootworm attacks, presumably because the root system of the cranberry is so much thriftier and more extensive in these soils than in sand and possibly because the beetles seek sandy soil in which to deposit their eggs.

The injury produced by the feeding of the beetles on the foliage and berries is so slight as to be almost negligible. This habit, however, affords a means of control, namely, of poisoning their food by the use of insecticides.

DESCRIPTION OF STAGES.

THE ADULT.

The adult (Pl. II, fig. 3) is a shining brown beetle measuring less than one-fourth of an inch in length. The following description of the adult is taken from Blatchley; those of the other stages are by the author.

Oblong, oval, convex. Brown, bronzed, strongly shining, the elytral margin often greenish-bronzed; antennæ and legs reddish-yellow, the outer joints of former often dusky; under surface of body greenish, abdomen brown, its tip paler. Head coarsely and sparsely punctate, clypeus more closely punctate. Thorax nearly twice as wide as long, narrowed in front, sides strongly curved, hind angles prominent; disk rather sparsely and finely punctate, elytra coarsely but not closely punctate, the punctures irregular on the disk, a line representing the third interval smooth. Length 4–5 mm.

THE EGG.

The eggs (Pl. II, fig. 2) of the cranberry rootworm measure 0.67 mm. in length by 0.30 mm. in width. In shape they are regularly elongate, elliptical. When first deposited they are a dirty white in color, later becoming uniformly yellow. The shell is smooth and glistening, and sufficiently transparent to reveal the larval outline before hatching.

THE LARVA.

The full grown larva (Pl. II, fig. 5) measures from 7–9 mm. Normally it lies in a curved position so that its full length is seldom revealed. Its color is whitish with head light brown and thoracic shield of very pale yellowish brown. Tips of mandibles black, shading off to light brown at the base. Labrum and clypeus brown. A row of brownish spines, the ambulatory setæ, on each ventral abdominal segment projects obliquely backward. Setæ long. Legs slender and small.

THE PUPA.

The pupa (Pl. II, fig. 4) is slightly shorter than the extended larva, whitish in color. Spines on the head and thorax are longer and stouter than those in the larval

stage. The middle and posterior femora are each provided with one curved spine and two straight, more slender spines; two flattened hooklike spines, curving outward, are found at the posterior end of the abdomen.

LIFE HISTORY AND HABITS.

ADULT STAGE.

Emergence of the beetles from the soil begins about mid-June, the maximum number emerging in breeding cages June 28. This date will vary, however, depending upon the time of drawing the winter flood from the bog; as early as June 6 beetles in the process of hardening were taken from the soil whereas the latest capture of the season was made October 20. They are easily captured by sweeping the bog with a net and with more difficulty by searching in the fallen leaves and refuse which often form a layer of trash an inch or more in depth under the vines. The beetles go into the trash so that they may deposit their eggs in the soil, and to find them one must carefully turn over the litter. Some are on the vines, feeding usually on the new growth of foliage, which they attack from the outer margin. Others may be found on the small berries, gouging shallow furrows around the fruit. When disturbed they fly short distances, seldom more than three or four feet. A few cage experiments showed that the females are longer lived than the males, one female remaining alive 56 days.

EGG STAGE.

Eggs have been found in a cranberry bog lying in a mass just beneath the surface of the ground. In rearing cages they are most frequently deposited in masses but occasionally are found singly. The highest number found in one mass and known to have been laid by one female was 53 eggs. The average number of eggs per mass was 14. Caged beetles sometimes oviposited on the sides of the cage or on fallen leaves, but most frequently the eggs were inserted about an eighth of an inch in the soil. In a previous report on the cranberry rootworm the writer (1914) gave the length of the egg stage as 11 days. Further data show that this period varies from 6 to 11 days, averaging 8 days.

LARVAL STAGE.

The small larvæ find their food in the first inch or two inches of roots and soil and, owing to the fact that the fibrous roots are so abundant, it is presumed that the larvæ travel little in search of food. Larvæ may be found feeding at all times during the summer and until quite late in the fall, at which time some of them go deeper into the ground. November 17, Mr. H. K. Plank, of the Bureau of Entomology, found larvæ in a peat soil at depths ranging from an inch to 1 foot. December 1 the larvæ were found in the first 2 inches of a rather dry, sandy soil. When feeding ceases a round cell is formed in the soil within which the larva hibernates until spring. If the bog is flooded during the winter the larvæ remain dormant, at least until the winter

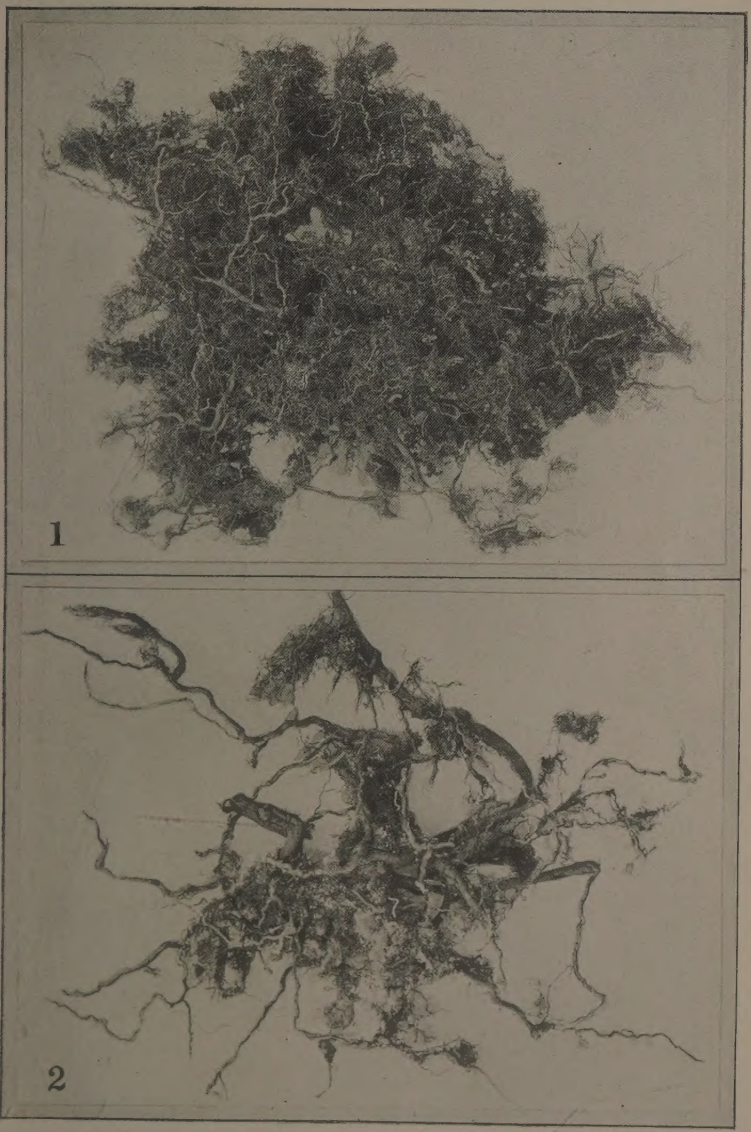

FIG. 1.—NORMAL ROOT SYSTEM OF THE CRANBERRY GROWN ON SAVANNA BOTTOM.
FIG. 2.—INJURY TO CRANBERRY ROOTS BY THE LARVÆ OF THE CRANBERRY ROOTWORM (RHABDOPTERUS PICIPES). (ORIGINAL.)

WORK OF THE CRANBERRY ROOTWORM.

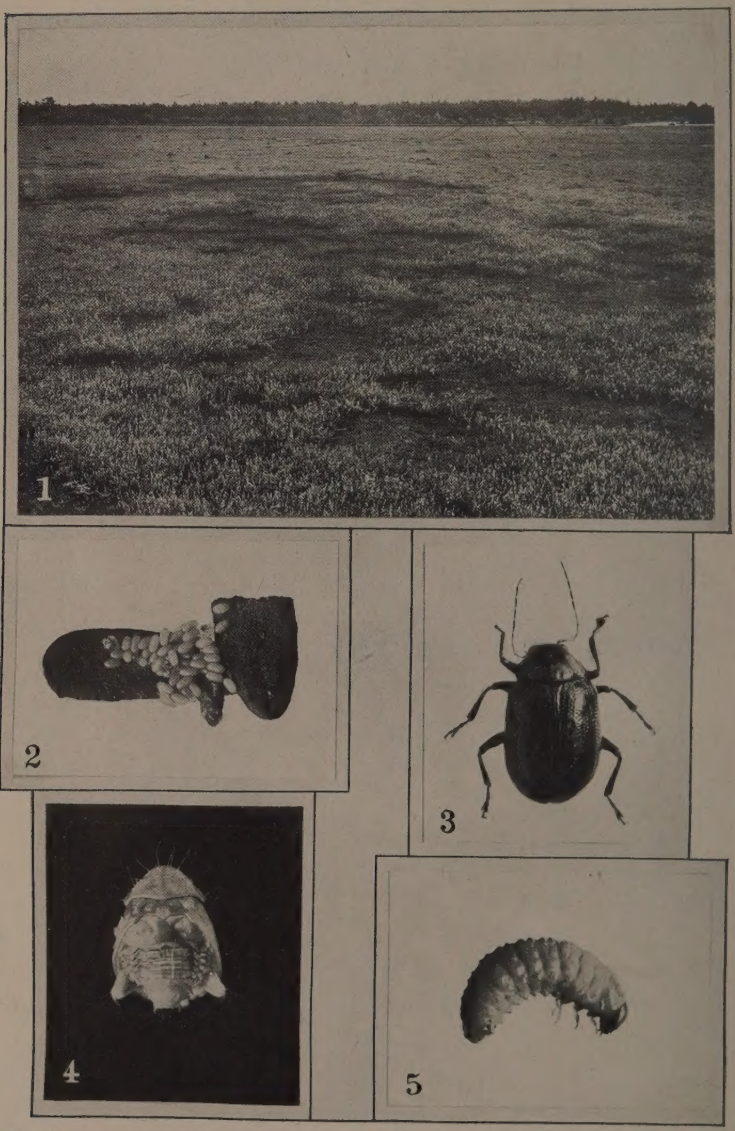

FIG. 1.—CRANBERRY BOG, SHOWING DEAD AREAS CAUSED BY THE LARVAL FEEDING OF THE CRANBERRY ROOTWORM (RHABDOPTERUS PICIPES). FIG. 2.—EGG MASS. FIG. 3.—ADULT. FIG. 4.—PUPA. FIG. 5.—LARVA. (ORIGINAL.)

THE CRANBERRY ROOTWORM AND ITS INJURIES.

flood is drawn in the spring. Soon after the water is drawn the larvæ commence to feed again, which may be noted by the fresh barking of the roots. Before commencing to pupate the larvæ move closer to the surface of the bog, the majority being found in the first inch of soil. Some idea of their abundance was obtained by counting the larvæ under plats of soil 10 inches square. Twelve larvæ were obtained in one instance and other counts of 11 and lesser numbers were made where the injury to the vines was quite apparent. From the foregoing it will be seen that the species spends most of its life in the larval stage, or approximately 10 months. Possibly some of the larvæ fail to mature at the expiration of this period and spend another year in the bog before reaching the adult stage.

PUPAL STAGE.

The time when pupation commences varies somewhat with the management of the bog. The earlier the flood is drawn the earlier will be the date of general pupation. In 1913, when the water was drawn April 1, pupæ were in the majority June 6; while in 1914, when the water was drawn May 20, the larvæ outnumbered the pupæ two to one on June 15. Pupation studies were carried on in wooden cages having glass bottoms, which permitted one to observe those larvæ which formed cells against the glass. The average duration of the pupal stage was found to be 14½ days, and from 2 to 3 days were spent by the adult hardening in the cell and reaching the surface.

SUMMARY OF LIFE HISTORY.

Stage.	Period of usual occurrence.	Range in occurrence.	Usual duration.	Range in duration.
			Days.	*Days.*
Adult	June 20–Aug. 1	June 6–Oct. 20	35	56
Egg	July 10–30	July 10–Sept. 3	8	6–11
Larva	July 16–June 1	All seasons (months)	10½	
Pupa	June 20–30	May 25–July 9	14½	13–17

RECOMMENDATIONS FOR CONTROL.

Some way in which to control an insect infestation by the use of water usually first suggests itself to one connected with the cranberry industry. The particular bog, however, upon which most of the observations were made has an insufficient water supply limited to a winter flooding with no available water for reflooding. Late holding of the water—that is, until May 20—had no effect in reducing the infestation. The larvæ were in as good condition after this treatment as when, the year previous, the water was drawn April 1. Laboratory experiments have shown that the larvæ can live submerged in clean water for as long as 41 days, while pupæ have not survived more than 9 days. Examination of a bog which had been reflowed for a period of 4 days in the latter part of May disclosed many live larvæ but no

dead ones. Another bog, in which the insects were found to have reached the pupal stage, was reflowed May 28 and 29 for a period of 27½ hours. Soon after the water was drawn from this bog a second investigation was made which revealed no dead pupæ and 49 live pupæ. Reflowing the bog when the beetles have emerged from the ground and before egg laying has commenced would undoubtedly carry some of the beetles ashore where they could be killed with kerosene, but this operation would have to come at a time when the young berries are forming, and the use of water at that time is apt to be disastrous to the setting of the crop.

Carbon bisulphid was given a trial to determine its effect on larvæ and pupæ in the soil. Used in holes at varying strengths of the liquid and varying depths and distances apart, negative results were obtained in each plat. In plat 1 the holes were made a foot apart and 4 inches deep and into each was poured one-half fluid ounce of carbon bisulphid. The liquid nearly filled each hole and all holes were covered with soil and tamped with the foot. Larvæ found within 2 inches of some of the holes were unaffected by the gas. The failure of this substance to kill is thought to have been due to the wetness of the bog which prevented the fumes from penetrating the soil. No injury resulted to the vines except where drops of the liquid were spilled on them from above.

Observations of two seasons' spraying on a bog near New Egypt, N. J., have shown that an arsenical, added to the customary Bordeaux and resin-fishoil soap used to control the fungous diseases of the cranberry, is of value in killing the beetles which feed on the foliage. Arsenite of lime at the rate of 1 pound of white arsenic per 200 gallons of Bordeaux mixture per acre was the poison applied by the owner of the bog the first year. Two applications were made, the first beginning July 1 and the second July 14. In 1914 the bog was sprayed more frequently owing to the presence of an infestation of fireworms (*Rhopobota vacciniana* Pack.). The dates of spraying were June 11, June 18, June 30, July 9, and July 20. Arsenite of lime was used in each instance, but beginning with the third application a different method of preparing it was employed, as follows—1 pound of caustic soda was dissolved in 2 quarts of water and while this was dissolving, 2 pounds of white arsenic were added. It is essential in preparing arsenite of soda after this formula that a very good grade of caustic soda be secured, otherwise some of the arsenic may remain uncombined and produce injury to the foliage or fruit. In five minutes the arsenic was completely dissolved, leaving a clear solution if the crystalline variety of arsenic was used, or a silt-colored solution if the amorphous arsenic was employed. The presence of a small amount of lead in the amorphous arsenic seemed to account for the cloudiness of the solution. Mr. F. S. Chambers, of J. J. White (Inc.),

New Lisbon, N. J., was the first to introduce this method of preparing arsenite of soda for use in the spraying of New Jersey cranberry bogs.

In the first two applications arsenic was used at the rate of $1\frac{1}{3}$ pounds per acre, the later applications being increased to 2 pounds per acre. Arsenite of lime, prepared and used as just described, is exceedingly cheap compared to arsenate of lead, but the dangers attendant upon its use by inexperienced help, both to human life and from possible injury to the foliage and fruit, are such that it is preferred to recommend arsenate of lead for general use. The latter insecticide is frequently used on cranberry bogs at the strength of 3 pounds of paste arsenate of lead to 50 gallons of water or Bordeaux mixture. If arsenite of lime is used as the insecticide, it is very essential that thorough agitation of the spray material be maintained. Some foliage injury, noted on three different bogs, should probably be attributed mainly to a neglect to keep the mixture agitated at all times when spraying. At the conclusion of the second season's observations no new areas on the sprayed bog were found infested and the number of larvæ throughout the bog had decreased to a marked degree.

Having observed on a number of bogs that the injury by the rootworm almost invariably occurs on sandy land and, further, that the root system of the cranberry on such land is exceedingly shallow as compared with that on peat or muck lands, it is fair to conclude that treatment of the bog by fertilizers to stimulate growth will be of great advantage to the cranberry plant in outgrowing the injury of the larvæ.

The New Jersey Experiment Station has amply demonstrated at Whitesbog, N. J., that weak vines on sandy soil can be made to produce an abundance of vines in one season by the application of the proper mixture of chemical fertilizers. It so happens that this land is infested with rootworms, but the extent of the infestation could not be definitely determined without tearing up the fertilizer plats more than is advisable. Some of the plats are known to be infested, but in spite of the presence of the rootworms the vines have made so much growth in two years that pruning would not be inadvisable.

Sanding infested areas also gives promise of being a satisfactory method of promoting vine growth. Mr. T. B. Gaskill, of New Egypt, N. J., has clearly demonstrated on a small, badly infested area of savanna land that a 1-inch coat of sand will cause the vines to grow vigorously, sending out runners which cover the bare spaces, and to present a marked contrast to unsanded adjacent vines.

SUMMARY.

The cranberry rootworm (*Rhabdopterus picipes* Oliv.) is the larva of a small brown beetle which has recently been found on a number of cranberry bogs in New Jersey.

It is widely distributed throughout the United States, but previous to its discovery on the cranberry it was not regarded as of economic importance.

The number of its known food plants is few.

The chief injury to the cranberry is produced by the feeding of the larvæ on the roots. The beetles feed on the foliage and fruit.

Its injury occurs mainly on sandy land or savannas, where the root system of the vines is not so extensive as on muck or peat bottoms.

The beetles appear in numbers about the end of June, deposit eggs in the soil, and die before fall.

The larvæ feed on the fibrous roots and bark of the larger roots until late fall, when they hibernate in cells formed in the soil.

Some spring feeding of the larvæ occurs.

Pupation commences early in June, the average duration of the stage being 14½ days.

No satisfactory practice in the use of the winter flowage or the spring reflowage to exterminate an infestation of larvæ or pupæ has been developed.

Invigorating the vines by the application of fertilizers or sand promises excellent results.

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